

1 **"DIAGNOSTIC SAFETY INSPECTION APPARATUS"**

2

3 FIELD OF THE INVENTION

4 The invention relates to diagnostic devices for performing safety
5 inspections on cargo trailers and more particularly to performing testing of electrical
6 circuits and air pressure circuits for braking systems.

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8 BACKGROUND OF THE INVENTION

9 Commercial cargo hauling trailers are equipped with numerous safety
10 and signaling features. Typically trailers are equipped with brake lights, turn signals,
11 tail lights, marker lights which are located at the top and along the length of the
12 trailer to indicate the extent of the trailer and an ABS warning light. Typical safety
13 systems include pneumatic braking systems, often augmented with an ABS system,
14 for both primary braking and emergency braking. During prolonged use, electrical
15 circuits which operate the signaling systems, and pneumatic lines connected to the
16 braking systems, are subject to wear and tear which may compromise their integrity.

17 Most countries have regulations, such as those of the US Department
18 of Transport and Transport Canada, which require regular, scheduled inspection of
19 all electrical circuits which power the signaling systems and pressurized air systems
20 which are integral to the braking systems on all commercial trailer units.

21 It is a well known practice to require two inspectors to check the trailer
22 systems. Typically, the trailer is connected to a towing vehicle, such as a tractor, in
23 order to supply power and air to the systems. A first inspector sits in the cab of the

1 tractor and applies all of the systems while a second inspector moves about the
2 periphery of the trailer observing the operation of the various signaling devices and
3 listens for air leaks and the like in the pneumatic lines connected to the brakes. This
4 process is labor intensive and costly, requiring two individuals and necessitates
5 coupling each trailer to be inspected to a towing vehicle, prior to inspection.

6 Others have attempted to provide diagnostic devices which can be
7 operated by a single inspector without requiring a towing vehicle. One such
8 diagnostic device is taught in US Patent 6,323,651 to Melendez. The device plugs
9 into the electrical connector of a trailer and permits a single inspector to selectively
10 check illumination and signaling circuits on the trailer as well as periodically
11 actuating the pneumatic system of the trailer at pre-selected intervals. Each trailer
12 circuit is connected to a separate control switch on a housing which has a visual
13 indicator to indicate whether the circuit is functioning properly. Further, the housing
14 is connected to the primary and emergency pneumatic lines on the trailer and has a
15 valve connected to a timer which cycles the pneumatic brake systems on and off at
16 preset time intervals while the operator or inspector checks for air leaks and
17 lubricates and adjusts the brakes. Applicant believes that the preset interval between
18 activation and deactivation of the pneumatic brakes is insufficient, either to locate a
19 non-obvious air leak or to effect lubrication and the like.

20 A remote control device for enabling point by point inspection is taught
21 in US Patent 6,154,035 to Aguirre et al. A main unit is coupled to a power source, a
22 source of pressurized air and to the trailer. A receiver module is incorporated into the
23 main unit for receiving information transmitted from a hand held remote control

1 device. Commands from the remote control device act to active and deactivate
2 switches from an open to a closed state to test the various electronic systems on the
3 trailer. A pneumatic valve which controls air flow to the pneumatic brake systems
4 can be remotely switched from an off-state to an on-state to permit inspection of the
5 air-brake application and release. Applicant's experience with hand-held remote
6 transmitters is that the transmitter is often easily misplaced or damaged through
7 rough handling in use or when stored in a vehicle or tool box.

8 Clearly, what is required is a robust portable diagnostic device that can
9 be easily connected to a trailer for testing electronic circuits and braking systems
10 that can be operated, particularly with regards to the brakes, in a variety of ways in
11 order to provide the inspector with maximum flexibility to diagnose and affect repairs
12 to both the signaling and the braking systems.

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SUMMARY OF THE INVENTION

2 The present invention is an improved diagnostic device for use by a
3 single inspector in inspecting commercial cargo-hauling trailers. The device
4 comprises pneumatic and electrical circuitry and particularly, a unique enhanced
5 circuit connecting a programmable timer circuit, which cycles the pneumatic braking
6 systems on the trailer between an applied state and a released state using a
7 solenoid, to a brake light circuit connected to the solenoid through a pressure
8 actuated switch. Actuation of the brake light circuit, when the system is charged with
9 air, causes the solenoid to be powered through the pressure actuated switch thus
10 overriding the cycling of the braking systems to apply a continuous stream of air to
11 the brakes permitting detection of leaks. Thus, the inspector can simply flip a toggle
12 switch connected to the brake light circuit on the diagnostic device each time he
13 wishes to alter the state of pneumatic braking systems on the trailer.

14 In a broad aspect of the invention, the improved diagnostic device
15 comprises: a pneumatic circuit adapted for connection to pneumatic braking systems
16 on the trailer; means such as a solenoid responsive to an electrical signal, for cycling
17 the pneumatic circuit between an applied state wherein air is supplied to the trailer's
18 pneumatic braking systems and a released state wherein air is released from the
19 trailer's pneumatic braking systems; an adjustable timer circuit, electrically
20 connected to the means for cycling the pneumatic circuit for controlling a timed
21 interval between the applied state and the released state; a diagnostic brake light
22 circuit adapted for connection to a brake light circuit on the trailer, the diagnostic
23 brake light circuit having a circuit switch operable to transmit an electrical signal in

1 on-state and preferably having an indicator means for connection thereto; and a
2 pressure actuated switch, connected between the means for cycling the pneumatic
3 circuit and the diagnostic brake light circuit, and operable between an electrically
4 conductive state when pressure is applied to the pressure actuated switch and an
5 electrically non-conductive state when pressure is released from the pressure
6 actuated switch, wherein when the pneumatic circuit is in the applied state causing
7 pressure to be applied to the pressure actuated switch and when the diagnostic
8 brake light circuit is in the on-state, the electrical signal from the brake light switch is
9 conducted through the pressure actuated switch to the means for cycling the
10 pneumatic circuit, maintaining the pneumatic circuit in the applied state, regardless
11 of the state of the timer circuit.

12 Preferably, the circuits are actuated through corresponding toggle
13 switches, presented on a control panel of a housing. Indicator lights, corresponding
14 to each toggle switch, are wired to each circuit and illuminate to indicate operation of
15 each circuit. An infinitely programmable timer, connected to the timer circuit is
16 accessed at the control panel to permit setting of any desired interval between an
17 applied and a released state of the pneumatic braking systems.

18 The diagnostic device is supplied with air from a source of compressed
19 air connected to the pneumatic circuit within the housing and through an air supply
20 valve within the housing to the trailer's pneumatic braking systems.

21 Preferably, in a preferred embodiment of the invention, a plurality of
22 electrical circuits having associated toggle switches and indicator lights are also

1 included for inspecting the electrical signaling circuits, such as turn signals, tail
2 lights, marker lights and ABS brake lights.

3 Advantageously, the diagnostic device is portable and can be mounted
4 in a cart or two-wheeled dolly, including a power supply such as a 12V battery and
5 an air supply, mounted on a mobile service truck or mounted on the wall of a shop
6 for inspection of trailers in a service bay. Air supply lines and electrical connections
7 are sized having a suitable length depending upon the particular mounting
8 arrangement use.

1 BRIEF DESCRIPTION OF THE DRAWINGS

2 Figure 1 is a perspective view of a an embodiment of a diagnostic
3 device of the present invention illustrating an exterior of the device;

4 Figure 2a is a plan view of the exterior control panel according to Fig.
5 1;

6 Figure 2b is a front view of the exterior according to Fig. 1, illustrating
7 power and pneumatic connections;

8 Figure 2c is a rear view of the exterior according to Fig. 1;

9 Figure 3 is a schematic plan view illustrating a pneumatic circuit
10 housed within the diagnostic device according to Fig. 1;

11 Figure 4 is a schematic illustrating the connection between a timer
12 circuit, a brake light diagnostic circuit and a pneumatic circuit housed within the
13 housing according to Fig. 1; and

14 Figure 5 is a schematic illustrating a plurality of signaling light,
15 diagnostic circuits housed within the housing according to Fig. 1.

1 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

2 Having reference to Figs. 1 and 2a-c, one embodiment of an improved
3 diagnostic apparatus 1 is shown for use in inspecting commercial cargo-hauling
4 trailers. The diagnostic apparatus 1 comprises a housing 2 which houses a plurality
5 of electrical circuitry and pneumatic circuitry adapted for connection to a plurality of
6 electrical signaling circuitry and to pneumatic braking systems on the trailer (not
7 shown), which is to be inspected. A control panel 3 on a top 4 of the housing 2
8 permits an inspector to select individual circuits to be tested.

9 The control panel 3 has an electrical plug connector 5 into which the
10 trailer electrical receptacle (not shown) is plugged, connecting the diagnostic device
11 1 to the signaling circuits on the trailer. A series of toggle switches 6 are used to
12 select individual circuits and a series of corresponding incandescent indicator lights
13 or LED's 7 provide visual confirmation of the corresponding circuits operation.

14 In a preferred embodiment, as seen in Fig. 2a, the indicator lights 7
15 and corresponding circuitry, best seen in Fig. 5, are arranged conveniently as
16 follows, beginning at the left of the control panel 3: left hand turn signals 30, right
17 hand turn signals 31, tail lights 32, marker lights 33, ABS warning light 34, diagnostic
18 device timer 35 and brake lights 36.

19 Further, a timer 8 is accessible at the control panel 3 for altering the
20 timing of cycling of pneumatic circuits to permit testing of the braking systems.

21 Best seen in Figs. 1 and 2b, pneumatic circuits P comprise a service
22 hose fitting 9 and an emergency hose fitting 10, situated on a front 11 of the housing
23 2 for connection to corresponding service and emergency pneumatic lines on the

1 trailer. An air inlet 12 is also situated on the front 11 of the housing 2 for connection
2 to an air supply (not shown), such as an air compressor, for providing a source of
3 compressed air to the pneumatic circuits P in the housing 2 and on the trailer.
4 Further, electrical contact posts 13, 14 are provided for connection to a power
5 source (not shown), typically a 12 volt battery, for providing electrical power to the
6 diagnostic device 1 and to the trailer's electrical circuits.

7 As shown in Figs. 2c and 3, compressed air A entering the air inlet is
8 supplied to an air supply valve 20 which, on demand, routes the air A directly to the
9 emergency hose fitting 10 and to the emergency hose on the trailer and to means on
10 the pneumatic circuit P for alternating between applied and released states. Means,
11 such as a solenoid 21, are responsive to an electrical signal. The solenoid valve 21
12 controls flow of air A to supply hose fitting 9 connected to a supply line on the trailer.
13 A pressure gauge 22 situated on a back 13 of the housing 2, is used to indicate the
14 pressure of air A being supplied for testing. Typically, testing is performed using a
15 minimum of 85 psi (586 kPa) and more preferably 100 psi (689 kPa).

16 A manual air supply knob 23 protrudes from the back of the housing 2
17 and is connected to the air supply valve 20 to permit charging the emergency line on
18 the trailer through the emergency hose fitting 10 and the solenoid 21 with air A when
19 depressed. Following testing, the air supply knob 23 is released by pulling out, which
20 resets the pneumatic circuit P of the diagnostic device 1.

21 Having reference to Fig. 4, in order to permit testing of the pneumatic
22 braking systems on the trailer, a three-way form of the solenoid 21 supplies
23 compressed air to the trailer's service line, and is controlled by the timer 8 between

1 an applied state in which air A is supplied to the trailer, and a released state in which
2 air A is vented V through the solenoid 21 to atmosphere into the housing 2.
3 Preferably, the timer 8 has an infinitely programmable time selection to permit
4 cycling of the air A to the trailer between the applied state and the released state. A
5 desired interval, sufficient to diagnose and service the braking systems, can be set
6 by the inspector. Thus, the inspector can move about the trailer as the brakes cycle
7 off and on to detect any leakages or to provide service to the brakes. One such timer
8 is a Potter Brumfield CNT 35-26 programmable multifunction digital time delay
9 relay/counter. Time intervals are infinitely programmable between 0.1 sec and 9,990
10 hours using thumbwheel switches 40, the preset time of each cycle being displayed
11 on a digital display 41. Typically, the timer 8 is set to be programmable between 0.1
12 and 999 seconds.

13 A timer circuit T, the pneumatic circuit P and a diagnostic brake light
14 circuit B are shown. The timer 8 is connected to the pneumatic circuit P through
15 solenoid 21. Further, the solenoid 21 is connected to the diagnostic brake light circuit
16 B through a pressure actuated switch 50 which acts alternately between an
17 electrically conductive state and an electrically non-conductive state. The electrically
18 conductive state is achieved as a result of pressure supplied by the pneumatic circuit
19 P. The electrically non-conductive state is achieved when air is not supplied to the
20 pneumatic circuit P.

21 Accordingly, when the pressure actuated switch 50 is in the electrically
22 conductive state, there is an electrical connection between the solenoid 21 and the
23 diagnostic brake light circuit B. Serendipitously, when testing for air leaks, the

1 diagnostic brake light circuit B can be used to hold the pneumatic circuit P in an
2 applied state without the need for a separate pneumatic circuit. Provided the
3 pneumatic circuit P is charged with air A, and when the brake light toggle switch 48
4 is turned on, the solenoid 21 is powered through the diagnostic brake light circuit B
5 and acts to apply air to the signaling circuit's brake light 57 on the trailer regardless
6 of the state of the timer 8.

7 As shown in Fig. 4, this enhanced circuit is achieved as follows. The
8 brake light circuit B comprises a brake light toggle switch 48 which is connected
9 through circuit breaker 49 to the brake light 57 on the trailer when the trailer's
10 electrical receptacle is plugged into the electrical plug connector 5. Further, the
11 brake light toggle switch 48 is also connected to the brake light indicator light 36 on
12 the control panel 3 through circuit breaker 49. Normally, this is used independently
13 to test the brake lights. As stated earlier, the diagnostic brake light circuit B is also
14 connected through the pressure actuated switch 50 to the solenoid 21.

15 A timer toggle switch 47 is connected to the timer indicator light 35
16 which is also connected through a circuit breaker 52 to the timer 8. The timer 8 is
17 connected to the solenoid 21. When the timer toggle switch 47 is activated, the
18 timer indicator light 35 acts to indicate that the timer 8 is on and the solenoid 21
19 cycles between the on-state and the off-state.

20 Advantageously, as previously described, so as to permit the inspector
21 to seek out subtle air leaks or to perform prolonged servicing of the brake systems,
22 when the pneumatic circuit P is charged with air A, such as when the timer 8 is in the
23 applied state, concurrent activation of the brake light toggle switch 48 conducts a

1 current through the electrically conductive pressure actuated switch 50 to power the
2 solenoid 21 as long as the brake light circuit B is in an on-state. Air A is thus
3 supplied continuously to the brake systems on the trailer, regardless of the state of
4 the timer 8. Similarly, even when the brake light toggle switch 48 and diagnostic
5 brake light circuit B are off, the timer 8 cyclically powers and illuminates the brake
6 light 57 on the trailer and the indicator light 36 each time the pneumatic circuit P is in
7 the applied state and the pressure actuated switch 50 becomes conductive.

8 Having reference to Fig. 5, additional diagnostic electrical signaling
9 circuits, corresponding to the signal systems on the trailer, are shown. Preferably,
10 the diagnostic device 1 further houses a left hand turn signal circuit LH, a right hand
11 turn signal circuit RH, a tail light circuit TL, a marker light circuit M and an ABS
12 warning light circuit ABS. Each of the aforementioned circuits comprises a toggle
13 switch 61, 62, 63, 64, 65 and a respective indicator light 71 72, 73, 74, 75, each
14 connected to the corresponding circuitry on the trailer through circuit breakers 81,
15 82, 83, 84, 85. The left and right hand signal circuits LH, RH, further comprise
16 flashers 91, 92 connected between the toggle switches 61, 62 and the circuit
17 breakers 81, 82 to permit testing of the turn signals. The flashers 91, 92 cause the
18 indicator lights 71, 72 to flash when an intermittent power signal is passed from the
19 turn signal circuits on the trailer. Resistors R1, R2 are connected to each of the turn
20 signal circuits LH, RH at the circuit breakers 81, 82.

21 Preferably, the diagnostic apparatus 1 is mounted on a moveable cart
22 or dolly, service truck or on a wall of a service bay. The air supply and electrical

1 connections are of sufficient length to meet the needs of each different mounting
2 arrangement.

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4 IN USE

5 In a preferred embodiment of the invention, the diagnostic device 1 is
6 connected to the power source, preferably a 12 V battery, and to the trailer by
7 plugging the trailer light cord receptacle (not shown) into the diagnostic device's
8 electrical plug connector 5. Compressed air is supplied to the diagnostic device 1 by
9 connecting the source of compressed air to the air line inlet 12. The emergency and
10 service lines of the trailer are connected to the diagnostic device's emergency hose
11 fitting 10 and the service hose fitting 9, respectively. Thus, when air A is supplied
12 through the inlet 12, the air supply valve 23 can be depressed for charging air
13 directly to the emergency hose fitting 10 and to the solenoid 21. The timer 8 is set to
14 a desired interval and is actuated using the timer toggle switch 47. The timer
15 indicator light 35 is illuminated to indicate that the timer 8 is on. The timer 8 cycles
16 between the applied state, applying or charging air to the pneumatic circuit P and
17 causing the brakes on the trailer to be disengaged, and the released state, wherein
18 air is caused to be released or vented V through the solenoid 21 to atmosphere and
19 causing the brakes to be actuated. The timer 8 continues to cycle between an
20 electrically on-state (pneumatically applied state) and an off-state (pneumatically
21 released state) while the inspector moves about the trailer diagnosing leaks and
22 performing service.

1 Should the inspector require a continuous supply of air A to the brakes
2 to permit prolonged servicing or diagnosing of subtle air leaks, the brake light toggle
3 switch 48 is actuated simultaneously with a timing cycle wherein the solenoid 21 is in
4 an on-state and the air A is applied. Advantageously, power to be supplied from the
5 diagnostic brake light circuit B and through the pressure actuated switch 50 in the
6 electrically conductive state to the solenoid 21 causes a continuous air supply to the
7 brakes regardless of the state of the timer 8. Switching off the brake light toggle
8 switch 48 and the timer toggle switch 47 causes the solenoid 21 to de-energize and
9 vent V the air A from the trailer service line. Once testing and servicing has been
10 complete the air supply valve can be pulled out to reset the pneumatic circuit P.

11

12 Table I

13 Brake, timer and pneumatic circuit states and various outcomes

Brake light circuit B	Timer Circuit 8	Pneumatic circuit P	Air A to trailer	Brakes cycle	Brake light indicator light
ON	OFF	OFF	NO	NO	YES
ON	ON	ON	YES	NO continuous air	YES
ON	OFF	ON	YES	NO continuous air	YES
OFF	ON	ON	YES	YES	YES

14

15 Testing of the signaling systems can be performed by actuating the
16 individual toggle switches 61, 62, 63, 64, 65 of the electrical circuits LH, RH, TL, M,
17 ABS and observing the response at the trailer. While testing can be performed
18 simultaneously by actuating all of the toggle switches 61, 62, 63, 64, 65, it may be
19 advantageous to test each circuit LH, RH, TL, M, ABS individually. This is
20 particularly of importance to ensure that signaling systems such as tail lights 32 and

1 marker lights 33, which are required to be on separate circuits on the trailer, are in
2 fact wired separately. If a single toggle switch 63 or 64 is actuated and both the tail
3 lights 32 and marker lights 33 illuminate, it is easy for the inspector to note and cite
4 the deficiency.

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